In this study, emphasis was placed on anatomical variations as they pertain to tentorial notch dimensions, brainstem position within the notch, cisternal third nerve length, and inter–third nerve angle, which are likely to influence herniation syndromes and traumatic brain injury.

The tentorial aperture is a complex space that varies significantly in size and shape. Although this space is defined by the free edges of the tentorium cerebelli, it has remained anatomically elusive because of its three-dimensional anatomy, absence of blood vessels running along its edge, and only occasional calcification. By correlating this anatomical study with the development of improved MR and CT imaging methods, the neuroimaging definition of the tentorial aperture and the structures within this space should be enhanced. Introduction of a tentorial notch classification system and new observations relating to cisternal third nerve anatomy and brainstem position may help explain patterns of transtentorial herniation, susceptibility of the third nerve to compression, and mechanisms of brain concussive and inertial injury. Determination of notch type achieved using MR and CT images may influence the treatment of patients with intracranial pathological conditions.

The goals of this study were the following: 1) to develop a classification system for the tentorial notch; 2) to identify anatomical aspects of the tentorial notch, third cranial nerves, and brainstem, which may correlate with specific herniation patterns and predisposing features of brainstem injuries that are associated with concussion and acceleration–deceleration events; and 3) to establish an anatomical basis for interpretation of the tentorial notch on MR and CT images.

**Materials and Methods**

**Cadaveric Studies**

The unfixed heads of 110 human cadavers were opened in standard autopsy fashion within 12 to 48 hours after death. Exclusion criteria included any primary neurological cause of death including trauma, cerebrovascular accident, or infection. The values obtained in 10 specimens were discarded during the course of perfecting the dissection technique. In our final series there were specimens from 77 male and 23 female cadavers. The mean age at time of death was 42.5 years (range 18–80 years). Causes of death in this series included penetrating injury (27 cases), medical/natural (49 cases), and suicide (24 cases) including 16 overdoses, four hangings, one fall, one exanguination, one asphyxiation, and one decapitation.

The cadaveric dissection began with a saw cut that extended circumferentially from 2 cm up on the glabella to 3 cm superior to the inion. The skull cap was removed with the head placed at an angle of 45 to 60° above the horizontal plane. On opening the head, there

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**TABLE 1**

<table>
<thead>
<tr>
<th>Value</th>
<th>Age at Death (yrs)</th>
<th>ANW (mm)</th>
<th>MNW (mm)</th>
<th>PTL (mm)</th>
<th>NL (mm)</th>
<th>Cisternal Third Nerve Distance (mm)</th>
<th>AT Distance (mm)</th>
<th>IC Distance (mm)</th>
<th>Inter–Third Nerve Angle (°)</th>
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</table>

* SD = standard deviation.
The tentorial notch: anatomical variation, morphometric analysis, and classification in 100 human autopsy cases

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Object. Variations in the structure of the tentorial notch may influence the degree of brainstem distortion in transtentorial herniation, concussion, and acceleration–deceleration injuries. The authors examined the anatomical relationships of the mesencephalon, cerebellum, and oculomotor nerves to the dimensions of the tentorial aperture. On the basis of numerical data collected from this study, the authors have developed the first classification system of the tentorial notch and present new neuroanatomical observations pertaining to the subarachnoid third cranial nerve and the brainstem.

Methods. The mesencephalon was sectioned at the level of the tentorial edge in 100 human autopsy cases (specimens from 23 female and 77 male cadavers with a mean age at time of death of 42.5 years [range 18–80 years]). The following measurements were determined: 1) anterior notch width, the width of the tentorial notch in the axial plane through the posterior aspect of the dorsum sellae; 2) maximum notch width (MNW), the maximum width of the notch in the axial plane; 3) notch length (NL), the length of the tentorial notch from the superoposterior edge of the dorsum sellae to the apex of the notch; 4) posterior tentorial length, the shortest distance between the apex of the notch and the most anterior part of the confluence of the sinuses; 5) interfundiculocaudal (IC) distance, the distance from the interfundiculocaudal fossa to the superoposterior edge of the dorsum sellae; 6) apicotal (AT) distance, the distance from the tegmentum in the median plane to a perpendicular line dropped from the apex of the tentorial notch to the cerebellum; 7) cisternal third nerve distance, the distance covered by the cisternal portion of the third cranial nerve; and 8) inter–third nerve angle, the angle between the two third cranial nerves.

The quartile distribution technique was applied to all measurements. Mean values are presented as the means ± standard deviations. Quartile groups defined by NL (mean 57.7 ± 5.6 mm) were labeled long, short, and midrange, and those defined by MNW (mean 29.6 ± 3 mm) were labeled wide, narrow, and midrange. Combining these groups into a matrix formation resulted in the classification of the tentorial notch into the following eight types: 1) narrow (15% of specimens); 2) wide (12% of specimens); 3) short (8% of specimens); 4) long (15% of specimens); 5) typical (24% of specimens); 6) large (9% of specimens); 7) small (10% of specimens); and 8) mixed (7% of specimens). The IC distance (mean 20.4 ± 3.2 mm) was used to characterize brainstem position as prefixed (28% of specimens), postfixed (36% of specimens), or midposition (36% of specimens). The IC distance was correlated with the left and right cisternal third nerve distances (mean 26.7 ± 2.9 mm and 26.1 ± 3.2 mm, respectively) and the inter–third nerve angle (mean 57.3 ± 7.3°). The exposed cerebellar parenchyma within the notch, the relationship between the brainstem and tentorial edge, and the brainstem position varied considerably among individuals. The cisternal third nerve distance, its trajectory, and its anatomical relation to the skull base also varied widely. Two anatomically distinct segments of the subarachnoid third cranial nerves were characterized with respect to the skull base as suspended and supported segments.

Conclusions. The authors present a new classification system for the tentorial aperture to help explain variations in herniation syndromes in patients with otherwise similar intracranial pathological conditions, and responses to concussive and acceleration–deceleration injuries. The authors present observations not previously described regarding the position of the brainstem within the tentorial aperture and the cisternal portion of the third cranial nerves. A significant statistical correlation was discovered among specific morphometric parameters of the tentorial notch, brainstem, and oculomotor nerves. These findings may have neurosurgical implications in clinical situations that cause brainstem distortion. Additionally, this analysis provides baseline data for interpreting magnetic resonance and computerized tomography images of the tentorial notch and its regional anatomy.

Key Words • tentorium cerebelli • brain herniation • brain concussion • oculomotor nerve • brainstem • morphometric study

The syndrome of transtentorial herniation occurs in a wide variety of neurological conditions including tumors, hemorrhages and brain edema. If left untreated, transtentorial herniation progresses rapidly to death. Before the advent of direct neuroradiological imaging, the lethal consequences of brainstem compression due to uncal herniation were recognized clinicopathologically and first described by Meyer in 1920. Now, modern neuroimaging methods (MR imaging and CT scanning) routinely provide images of the tentorial notch, but little attention has been given to its anatomical variations and regional anatomy as they apply to unique herniation syndromes and to its importance during inertial injury and brain concussion. To date, information concerning anatomical variations in the tentorial notch is limited to classic studies performed before.
was no evidence in any specimen of traumatic injury, hemorrhage, edema, or infection. One specimen contained an incidental medial sphenoid wing meningioma measuring 1 cm in diameter. The dura mater over the vertex and the posterior falx were kept intact. The frontal lobes were lifted and the anterior falx was cut. The diencephalon was cut axially above the level of the optic chiasm, through the third ventricle to the apex of the tentorial notch. The cerebral hemispheres were removed, leaving intact a small portion of diencephalon, the posterior portion of the falx, and the tentorium. A second saw cut was made to remove the entire squama of the temporal bone down to the floor of the cranial fossa. The optic nerves were cut rostral to the sella turcica. The optic chiasm was lifted and the mesencephalon was cut at the level of the interpeduncular fossa in the axial plane, extending posteriorly. The brainstem cut followed the contour of the tentorial edge to the point of the notch apex. The vein of Galen was cut, the pineal gland removed, and the arachnoid dissected, allowing for a clear view of cerebellar anatomy within the tentorial notch. The field was irrigated to remove fresh blood. Photographs were taken from the superior and lateral views at a magnification of ×2 with a 200-mm zoom lens.

The following distances were measured (Fig. 1): 1) ANW, the width of the tentorial notch in the axial plane through the posterior aspect of the dorsum sellae; 2) MNW, the maximum width of the notch in the axial plane; 3) NL, the distance between the supero-posterior edge of the dorsum sellae in the median plane and the apex of the notch; 4) PTL, the shortest distance between the apex of the notch and the most anterior part of the confluence of sinuses; 5) the distances covered by the left and right cisternal portions of the third nerves, extending from the interpeduncular fossa to the nerves' entry through the dura mater into the cavernous sinus; 6) AT distance, the distance from the tectum in the median plane to a perpendicular line dropped from the notch apex to the cerebellum; 7) IC distance, the distance from the interpeduncular fossa to the supero-posterior edge of the dorsum sellae; and 8) inter-third nerve angle, the angle created by the two exiting third cranial nerves.

Measurements were taken from photographs with the exception of the PTL, which was measured in situ.

The inter-third nerve angle was determined by tracing the inner aspect of the right and left third nerves and measuring the angle of intersection at the interpeduncular fossa with the aid of a protractor. The quartile distribution technique was used to classify tentorial notch morphometry, brainstem position, and inter-third nerve angle. Maximum, minimum, mean, median, and standard deviation values were determined for each variable (Table 1). Correlation r values were determined for all variables by plotting each against the other.

Neuroimaging Studies

A specific tentorial MR imaging sequence was used to obtain images of the brain in the axial and sagittal planes in one healthy volunteer, two patients in whom there was no sign of intracranial disease, and seven patients who had sustained varying degrees of head trauma. The tentorial sequence was defined by high-resolution T₂-weighted images. The parameters for the sagittal images were the following: fast spin-echo/XT pulse sequence, thickness 3 mm, gap 0, TR 4000 msec, TE 100 msec, echo train length 18, signal averages 2, field of view 20, variable bandwidth 11 KHz, and matrix 256 × 256. The parameters for the coronal images were as follows: fast spin-echo/XT pulse sequence, thickness 3 mm, gap 0, TR 3400 msec, TE 100 msec, echo train length 18, signal averages 2, field of view 20, variable bandwidth 14 KHz, and matrix 320 × 256. The time required to obtain sagittal images was 2 minutes and 8 seconds, and the time required to obtain coronal images was 3 minutes and 38 seconds.

Results

In this study the relationships among the tentorial notch, mesencephalon, and oculomotor nerves were examined in 100 autopsy cases. One hundred data points were obtained for all variables. Correlation values greater than 0.4 and less than 0.4 were worthy of mention. No variable demonstrated strong correlation with age. The mean PTL was 48.3 ± 5.7 mm (range 35–63 mm). No significant correlation was present between this variable and others.

The MNW, NL, AT Distance, and ANW

The tentorial notch was categorized into six major groups by applying quartile analysis to the NL and MNW over a continuum of values. These groups were classified as long (26% of specimens), short (23% of specimens), and midrange (51% of specimens) for the NL, and wide (26% of specimens), narrow (27% of specimens), and midrange (47% of specimens) for the MNW. Combining these groups into matrix formation (Table 2) allowed us to classify the tentorial notch into eight types.

Using the variables NL and MNW to examine predominant structural features permitted typing of tentorial notches into categories of wide (12% of specimens), narrow (15% of specimens), long (15% of specimens), short (8% of specimens), and typical (24% of specimens). Notches that were both wide and long were labeled large (9% of specimens), and those that were narrow and short were labeled small (10% of specimens). The category of mixed notches (7% of specimens) was assigned to tentorial notches that were either wide and short (5% of specimens) or narrow and long (2% of specimens) (Table 3).

Table 4 summarizes the measurements demonstrated in associated figures. A tentorial notch with an MNW less than or equal to 27 mm and a midrange NL was characterized as narrow (15% of specimens; Fig. 2 left), and notches with an MNW greater than or equal to 32 mm and a mid-
<table>
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<tr>
<th>Figure No.</th>
<th>Notch Type</th>
<th>Brainstem Position</th>
<th>ANW (mm)</th>
<th>MNW (mm)</th>
<th>NL (mm)</th>
<th>Cisternal Third Nerve Distance (mm)</th>
<th>AT Distance (mm)</th>
<th>IC Distance (mm)</th>
<th>Inter-Third Nerve Angle (°)</th>
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<td>32 33 16.5 26 45</td>
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</tbody>
</table>

* Mid = midposition; post = postfixed; pre = prefixed.

range NL were characterized as wide (12% of specimens; Fig. 2 right). A notch with a length less than or equal to 53.5 mm and a midrange MNW was characterized as short (8% of specimens; Fig. 3 left), and a notch with a length longer than or equal to 62 mm and a midrange MNW was defined as long (15% of specimens; Fig. 3 right). In cases in which the MNW and NL values fell between the first and third quartiles (midrange), the tentorial notch was defined as typical (24% of specimens). Using visual inspection, we found that 92% of wide notches were noncontiguous with the tentorial edge to varying degrees. A notch with a length and MNW within the first quartile was labeled small (10% of specimens; Fig. 4 left) and one with these values within the third quartile was labeled large (9% of specimens; Fig. 4

**Fig. 2.** Photographs. *Left:* A narrow tentorial notch is seen from above. Note the prefixed brainstem and a high degree of contiguity between the brainstem and the free tentorial edge. *Right:* A wide tentorial notch. Note the postfixed brainstem, the generous perimesencephalic space between the brainstem and the free tentorial edge, the labeled inter-third (Inter III) nerve angle and supported and suspended third nerve segments, and the large AT distance, allowing for greater cerebellar exposure within the notch.
right). Seven apertures were found to be both wide and short (5% of specimens), or long and narrow (2% of specimens); these tentorial notches were characterized as mixed.

The mean NL measured 57.7 ± 5.6 mm (range 44–70 mm) and the mean AT distance measured 16.8 ± 5.4 mm (range 4–32 mm). Correlation between these two values was significant (r = 0.77, p < 0.000001). Although the amount of cerebellar tissue exposed within the tentorial hiatus was not quantified, a positive visual correlation was present between exposed cerebellar parenchyma and the AT distance (Fig. 3).

The mean values of the ANW and MNW measured 26.6 ± 2.7 mm (range 21–34 mm) and 29.6 ± 3 mm (range 24.5–39 mm), respectively. As expected, a strong correlation between these two values existed (r = 0.76, p < 0.000001).

Cisternal Third Nerve Distance, IC Distance, and Inter–Third Nerve Angle

We obtained values for the cisternal third nerve distance, IC distance, and inter–third nerve angle. The mean left and right cisternal third nerve distances were 26.7 ± 2.9 mm (range 19–33 mm) and 26.1 ± 3.2 mm (range 20–35 mm), respectively.

A mean IC distance of 20.4 ± 3.2 mm (range 12–29 mm) was calculated. A significant correlation between the left and right cisternal third nerves and IC distance was present (r = 0.79 and r = 0.77, respectively, p < 0.000001). Using quartile cutoff points, the term “prefixed brainstem” (28% of specimens) was applied when the IC distance was less than or equal to 18 mm (Figs. 2 left, 3 left, 4 left, 5, and 6 upper). A postfixed brainstem (36% of specimens) was present when the IC distance was greater than or equal to 22 mm (Figs. 2 right, 4 right, and 6 lower). The brainstem was labeled midposition (36% of specimens) when the IC distance lay between 18 and 22 mm (Fig. 3 right).

The site of insertion of the third cranial nerve into the dura mater covering the cavernous sinus was variable. A postfixed brainstem, long cisternal third nerve distance, and small inter–third nerve angle was consistent with a more medial and distal entry into the cavernous sinus (Fig. 4 right). In contrast, a prefixed brainstem, short cisternal third nerve distance, and large inter–third nerve angle featured a more lateral third nerve trajectory and proximal entry into the cavernous sinus (Fig. 5).

There was a significant negative correlation between the inter–third nerve angle and the IC distance (r = −0.49, p < 0.000001). The correlation between the left and right cisternal third nerve distances and the inter–third nerve an-
Fig. 4. Photographs. *Left:* A small tentorial notch (narrow and short). Note the prefixed brainstem, the lack of space between the free edge of the tentorium and the mesencephalon, the short third cranial nerves, and minimal cerebellar tissue within the notch. *Right:* A large tentorial notch (wide and long). Note the postfixed brainstem, the more acute inter-third nerve angle, longer third cranial nerves, greater length of the freely suspended third nerve within the tentorial notch, and the greater posteroanterior projection of the third nerves.

The angle was also significant (left side, \( r = -0.47 \); right side, \( r = -0.56 \); \( p < 0.000001 \)). The mean inter-third nerve angle was 57.3 ± 7.3° (range 40°–75°). The quartile cutoff points were used to define a large inter-third nerve angle as one greater than or equal to 61°, a small angle as one less than or equal to 52.5°, and a midrange angle as one having values lying between the first and third quartiles.

We recognized that the cisternal third nerve may be divided into two segments with respect to the skull base: a suspended and a supported portion (marked in Figs. 2 right, 4 right, and 5). The freely suspended segment extends from the interpeduncular fossa to the petroclinoid ligament, whereas the supported segment rests on the skull base, extending from the ligament to the cavernous sinus. The suspended segment traverses the anterior free space of the tentorial hiatus, maintaining potential points of tethering at its brainstem origin, petroclinoid ligament, and dural insertion. Oculomotor nerves exhibited slack and variation in trajectory with respect to the axial plane. Therefore, measurements were not considered true representations of cisternal third nerve length.

**Tentorial Slope**

The free edges of the tentorium arise from the anterior clinoid processes; slope posteroinferiorly, reaching a nadir; and curve posterosuperiorly to meet in the midline at the apex of the tentorial notch. The space defined by these leaflets of dura mater is similar to that of the bow of a ship, the inclination of which is variable among individuals.

Although the tentorial inclination was not quantified in this study, there were marked visual differences in the curvilinearity of the tentorial edge when observed from the lateral projection. Short tentorial apertures appeared coincident with a steeper inclination and greater curvature of the tentorial edge (Fig. 6 upper), whereas long notches were flattened (Fig. 6 lower), exposing more notch contents to the supratentorial compartment. Extending posteriorly from its anterior clinoidal insertion, the tentorial edge sloped gently downward. It then assumed a variable upward slope toward the notch apex.

**Identification of the Type of Tentorial Notch on MR Images**

The same anatomical landmarks used in the autopsy portion of this study were demonstrated on MR images obtained in nine patients and one healthy volunteer (Table 5). The MNW was measured in the coronal plane, whereas the NL and IC and AT distances were measured in the mid-sagittal plane (Case 10 in Table 5 and Fig. 7). The AT distance was measured by marking a line from the tectum to

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FIG. 5. Photograph showing a mixed tentorial notch (wide and short). Note the prefixed brainstem, the large inter-third nerve angle, short third nerves, short length of the freely suspended third nerve within the tentorial notch, and the greater degree of mediodistal trajectory of the third nerve.

the anterior aspect of the vein of Galen. Notch type and brainstem position were determined for the volunteer and the nine patients.

Discussion

Notch Size and Inertial Injury

In 1958 Sunderland\(^5\) classified notches as broad or narrow and Corsellis\(^1\) suggested that patterns of herniation should be affected by notch size and shape. Although Sunderland and Corsellis clearly demonstrated anatomical variations in the tentorial notch and its relation to the brainstem, a well-defined classification system was not developed and no hypotheses were presented to explain patterns of tentorial herniation or the variable clinical sequelae that arise after concussive and inertial brain injury.

Although there is no unique center of consciousness, it has been suggested that the integrity of the brainstem reticular formation plays a key role in its maintenance.\(^5\)\(^,\)\(^1\)\(^,\)\(^2\)\(^,\)\(^3\)\(^,\)\(^5\)\(^,\)\(^8\)\(^,\)\(^9\)\(^,\)\(^10\)\(^,\)\(^12\)\(^,\)\(^13\)\(^,\)\(^14\)\(^,\)\(^15\)\(^,\)\(^26\)\(^,\)\(^27\)\) Brain concussion results in immediate and temporary loss of consciousness without gross anatomical change.\(^1\) Although histological and ultrastructural evidence of concussive injury in animal models\(^1\)\(^,\)\(^2\)\(^,\)\(^3\)\(^,\)\(^17\)\(^,\)\(^20\)\(^,\)\(^27\)\) has been found from the upper cervical spinal cord to as far rostral as the frontal lobe, the brainstem reticular formation appears to be the most common site for axonal dysfunction.

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<td>41, M</td>
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<td>mixed</td>
<td>midposition</td>
<td>32</td>
<td>50</td>
<td>20</td>
<td>14</td>
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* Included in the MR imaging portion of the study were seven patients suffering from head trauma (Cases 1-7), two patients in whom there was no evidence of intracranial disease (Cases 8 and 9), and one healthy volunteer (Case 10). Abbreviations: DA1 = diffuse axonal injury; hem = hemorrhage; ICH = intracerebral hemorrhage; SDH = subdural hematoma.

It is not surprising that variability exists in the location of these microscopic abnormalities found in animal studies. Klintworth\(^13\) showed that the tentorium and the tentorial notch differ significantly in orientation, size, and shape in different animal species. In fish, reptiles, and amphibians, the tentorium cerebelli is absent. In some mammals, such as the rat and guinea pig, this dural partition is incomplete and does not meet in the midline. In higher mammals, such as the monkey and human, the tentorial dura forms a crescentic diaphragm, which creates a partition between the cerebral and cerebellar hemispheres and a hiatus around the mesencephalon.\(^13\) These interspecies variations in the anatomy of the tentorium cerebelli are significant when one examines consistency among animal models of concussion. Extreme species variations in cephalic and tentorial anatomy makes the identification of pathophysiological correlates for human concussion and inertial injury difficult. The concept that concussion is a form of diffuse brain injury\(^6\) should be questioned. Instead, we suggest that mild, focal damage to the reticular core at the level of the mesencephalon may constitute a primary brainstem locus and morphological substrate for concussion. This suggestion is in keeping with the study published by Jane, et al.,\(^22\) in which experimental concussion produced in the monkey caused pathological changes confined to the brainstem. On the basis of the anatomical findings in this study, previous experimental animal data, and the fact that brief loss of consciousness is the clinical substrate for dysfunction of the median raphe and reticular core, we speculate that the sharp, free tentorial edge may play a direct role in the transmission of kinetic energy to the immediately adjacent or contiguous midbrain.

Notch Width and Transtentorial Herniation

The signs, symptoms, and neuroanatomical distortions that occur with parenchymal herniation through the ten-
Fig. 6. Photographs. **Upper:** Photograph of a small tentorial notch with a right lateral view of the free edge of the tentorium. Note the curvilinearity of the free tentorial edge, the edge of the cerebral peduncle abutting the tentorial edge, and a small amount of exposed third cranial nerve (suspended segment). **Lower:** Lateral view of a large tentorial notch from the same specimen as that shown in Fig. 4 right. Note the flattened tentorial edge, the exposed cerebellum, and a portion of the third cranial nerve.

torial aperture were elucidated during the first half of the 20th century by a number of authors. Uncal herniation at the level of the notch was characterized, and terms such as “temporal pressure cone,” “tentorial pressure cone,” and “transtentorial herniation of the brainstem” were applied to this pathological process. Since the landmark anatomical studies performed by Corsellis and Sunderland in 1958, however, the variety of clinical presentations resulting from transtentorial herniations have not been ascribed specific anatomical correlates. We concur with Corsellis and Sunderland that the morphometry of the tentorial notch, together with the location of supratentorial pressures and the rapidity with which they change, plays a key role in determining herniation patterns and that certain anatomical arrangements confer “a measure of protection,” whereas others may predispose to early brainstem compromise.

Experimentally, the constellation of signs and symptoms associated with herniation were reproduced in the monkey and pathologically examined by Munro, et al., and Schwarz, et al. The neuropathological sequelae of transtentorial herniation were consistently found and demonstrated grooving and contralateral displacement of the brainstem, medial displacement and herniation of the hippocampal gyrus, compression of the third cranial nerves, and brainstem hemorrhages. Despite our clinicopathological understanding of transtentorial herniation, the reasons for differing signs of neurological deterioration that appear among patients remain unclear. Similarly, the anatomical mechanism for the occurrence of a false localizing sign is understood, but its incidental occurrence has been difficult to explain. The dissimilarity in tentorial notch morphology and regional anatomy may help elucidate this phenomenon.

It has been shown that long and wide notches contain a greater amount of cerebellar tissue than short and narrow notches. We also noticed a strong relationship between large apertures and the amount of exposed cerebellar tissue. In contrast, small apertures contained minimal cerebellar tissue. These findings may have implications regarding the
propensity for transtentorial herniation of cerebellar or cerebral parenchyma in a rostral or caudal direction, respectively.

**Brainstem Position, Cisternal Third Nerve Distance, and Inter–Third Nerve Angle**

For the first time interpedunculocivil distance, cisternal third nerve distance, and inter–third nerve angle were measured. The interpeduncular fossa was used as a point from which to measure the distance from the midbrain to the dorsum sellae, and was referred to as the IC distance. The positional relationship of the brainstem to the clivus was defined by the IC distance. On the basis of this measurement, the terms “prefix,” “midposition,” and “postfix” were applied to the brainstem position within the tentorial aperture. Variations in the amount of space between the brainstem and clivus may have similar implications to those of the space between the cerebral peduncles and the tentorial edge, when one assesses the potential for brainstem injury from blows to the head, acceleration–deceleration events, or mass lesions causing transtentorial herniation. Herniation of the hippocampal gyrus over the free edge of the tentorium cerebelli causing direct pressure on the third cranial nerve is the accepted explanation for pupillary dilation during transtentorial herniation.\(^{16,19,20}\) The presence

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**Fig. 7.** Case 10. Magnetic resonance images obtained in a healthy volunteer. **Upper Left:** Coronal image allowing the determination of the MNW in the axial plane. **Upper Right:** Sagittal image allowing determination of the NL, the distance from the upper edge of the dorsum sellae to the notch apex, defined by the anterior aspect of the vein of Galen measured in the midsagittal plane. **Lower Left:** Sagittal image allowing determination of the IC distance, the distance from the interpeduncular fossa in the midline to the upper edge of the dorsum sellae measured in the midsagittal plane. **Lower Right:** Sagittal image allowing determination of the AT distance, which is, with respect to MR imaging, the distance from the tectum at the midline to the anterior aspect of the vein of Galen measured in the midsagittal plane.
of unilateral or bilateral pupillary dilation in proven cases of transtentorial herniation, however, is not a constant finding. Anatomical variations in third nerve length, trajectory, and degree of suspension within the tentorial hiatus may serve as a partial explanation for inconsistencies in pupillary findings during transtentorial herniation.

Identification of Notch Type on Neuroimages

The dorsum sellae, interpeduncular fossa, and notch apex are anatomical landmarks easily seen on sagittal, axial, and coronal MR and CT images. Using these studies, IC and AT distances and the NL and MNW may be measured. In this study, correlational measurements on MR images were obtained in 10 individuals. Notch type and brainstem position were identified. Using these images and measurements, determination of the size of the tentorial aperture and the position of the brainstem is straightforward, requires little time, and helps characterize neuroanatomical variations in this region.

Conclusions

For the first time the following goals have been achieved: 1) a classification system of the tentorial notch has been presented; 2) the IC, AT, and cisternal third nerve distances and the inter-third nerve angle have been measured; and 3) suspended and supported segments of the subarachnoid third cranial nerve have been identified. On the basis of this study, we believe that morphometric variations in the tentorial aperture and its regional anatomy may be implicated in the different clinical presentations related to transtentorial herniation, concussion, and acceleration–deceleration injury. The importance of these data is reflected in statistically significant correlations that shed light on anatomical features of the tentorial notch, brainstem, and oculomotor nerves. In conclusion, the use of neuroimaging to identify the type of the tentorial notch and its regional anatomy may facilitate neurosurgical decision making.

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References